

CLAIMS

1. Method of processing a set of coefficients ( $X_{ij}$ ) representing a digital image (300) with a view to an insertion of at least one item of watermarking information (W') in said image, this image being liable to undergo a set of geometric transformations and said coefficients being grouped together in regions (B'), said method being characterised in that it includes the following steps:

- determining (E220), amongst at least some of said regions (B'), a set of so-called acceptable regions, adapted to receive said at least one item of watermarking information (W'); and
- sequencing (E230), according to at least one predetermined criterion, at least one part of said set of acceptable regions (B'), in an order which is invariant with respect to at least one of said geometric transformations.

2. Method according to Claim 1, characterised in that said at least one part of said set of acceptable regions is sequenced, according to said at least one predetermined criterion, in an order which is invariant with respect to at least one combination of at least some of said geometric transformations.

3. Method according to Claim 1 or 2, characterised in that the set of geometric transformations includes identity, rotations through 90, 180 (A20) and 270 degrees, vertical axis symmetry (A10), vertical axis symmetry (A10) followed by a rotation through 90 degrees, vertical axis symmetry followed by a rotation through 180 degrees and vertical axis symmetry followed by a rotation through 270 degrees.

4. Method according to any one of Claims 1 to 3, characterised in that the step (E230) of sequencing said at least one part of said set of acceptable regions (B') is performed according to at least one predetermined geometric criterion ( $G_x$ ) whose value for a set of coefficients ( $X_{ij}$ ) is independent of said coefficients of the image.

5. Method according to any one of Claims 1 to 4, characterised in that said regions ( $B^i$ ) of coefficients representing a digital image correspond to the frequency sub-bands of a wavelet decomposition (DWT) of said digital image.

5 6. Method according to Claims 4 and 5, characterised in that said geometric criterion ( $G_k$ ) is chosen from amongst the size of a region, its index of the resolution level, its type of sub-band and the distance from its centre to the centre of its sub-band.

10 7. Method according to any one of Claims 1 to 6, characterised in that the step (E230) of sequencing said at least one part of said set of acceptable regions ( $B^i$ ) is performed according to at least one predetermined criterion ( $S_k$ ) whose value for a set of coefficients ( $X_{ij}$ ) depends on the coefficients of said set.

15 8. Method according to Claim 7, characterised in that the step (E230) of sequencing said at least one part of said set of acceptable regions ( $B^i$ ) includes notably an evaluation of the values ( $S'_k(+1)$ ,  $S'_k(-1)$ ) which would be taken by said criterion ( $S_k$ ) during the insertion of said at least one item of watermarking information ( $W$ ).

20 9. Method according to Claims 4 and 7, characterised in that the sequencing step (E230) is performed according to a subset of geometric criteria ( $G_k$ ) before being performed according to a subset of criteria ( $S_k$ ) whose value for a set of coefficients ( $X_{ij}$ ) depends on the coefficients of said set.

25 10. Processing method according to any one of Claims 1 to 9, characterised in that said acceptable regions ( $B^i$ ) are such that the probability of detection of said at least one item of watermarking information received by these regions is greater than a predetermined threshold.

30 11. Method of watermarking a set of coefficients ( $X_{ij}$ ) representing a digital image (300) which is liable to undergo a set of geometric transformations and said coefficients being grouped together in regions ( $B^i$ ), said method being characterised in that it includes the following steps:

- determining (E220) a set of so-called acceptable regions ( $B'$ ) and sequencing (E230), according to at least one predetermined criterion, of at least one part of said set of acceptable regions, in an order which is invariant with respect to at least one of said geometric transformations, according to one

- inserting at least one item of watermarking information ( $W'$ ), for at least certain regions of said at least one part of said set of acceptable regions, said at least one item of watermarking information ( $W'$ ) being invariant with respect to at least one of said geometric transformations.

12. Method according to Claim 11, characterised in that said at least one item of watermarking information ( $W'$ ) is invariant with respect to at least one combination of at least some of said geometric transformations.

13. Method according to Claim 11 or 12, characterised in that the insertion of said at least one item of watermarking information ( $W'$ ) for a region ( $B'$ ) of said one part of said set of acceptable regions corresponds to a spreading of a pseudo-random signal in all the coefficients ( $X_{i,j}$ ) of said region.

14. Method according to Claim 13, characterised in that the pseudo-random signal spread in all the coefficients of a region is dependent on said region.

15. Method according to Claim 14, characterised in that it includes a step of generating the pseudo-random signal dependent on said region ( $B'$ ) using a key ( $K(B')$ ) specific to said region ( $B'$ ) and which is dependent on a secret global key ( $K$ ).

16. Method of decoding a watermarking code ( $C'$ ) obtained from at least one item of watermarking information ( $W''$ ) inserted in a set of coefficients ( $X'_{i,j}$ ) representing a digital image (320), this image (320) being liable to have undergone a set of geometric transformations and said coefficients being grouped together in regions ( $B''$ ), said method being characterised in that it includes the following steps:

- determining (E720), amongst at least some of said regions ( $B''$ ), a set of so-called acceptable regions, adapted to receive said at least one item of watermarking information ( $W''$ );

5       - determining a set of so-called watermarked regions ( $B''$ ) amongst said set of acceptable regions, said watermarked regions ( $B''$ ) having received said at least one item of watermarking information ( $W''$ );

- decoding (E730) said at least one item of watermarking information ( $W''$ ) for each of said watermarked regions ( $B''$ );

10       - sequencing (E740) said watermarked regions ( $B''$ ) according to at least one predetermined criterion, in an order which is invariant with respect to at least one of said geometric transformations; and

- reconstituting said watermarking code ( $C'$ ) by sequencing said watermarking information ( $W''$ ) as a function of said sequencing of said watermarked regions.

15       17. Method according to Claim 16, characterised in that said watermarked regions ( $B''$ ) are sequenced, according to said at least one predetermined criterion, in an order which is invariant with respect to at least one combination of at least some of said geometric transformations.

20       18. Method according to Claim 16 or 17, characterised in that said at least one item of watermarking information ( $W''$ ) is invariant with respect to at least one of said geometric transformations.

25       19. Method according to any one of Claims 16 to 18, characterised in that said at least one item of watermarking information ( $W''$ ) is invariant with respect to at least one combination of at least some of said geometric transformations.

20. Method according to any one of Claims 16 to 19, characterised in that said acceptable regions ( $B''$ ) are such that the probability of detection of said at least one item of watermarking information received by these regions is greater than a predetermined threshold.

30       21. Method according to any one of Claims 16 to 20, characterised in that said at least one item of watermarking information ( $W''$ ) received by a

watermarked region ( $B''$ ) is a pseudo-random signal spread in all the coefficients ( $X'_{ij}$ ) of said region.

22. Method according to Claim 21, characterised in that said pseudo-random signal spread in all the coefficients of a watermarked region is  
5 dependent on said watermarked region.

23. Device for processing a set of coefficients ( $X_{ij}$ ) representing a digital image (300) with a view to an insertion of at least one item of watermarking information ( $W'$ ) in said image, this image (300) being liable to undergo a set of geometric transformations and said coefficients ( $X_{ij}$ ) being  
10 grouped together in regions ( $B'$ ), said device being characterised in that it has:

- means of determining, amongst at least some of said regions, a set of so-called acceptable regions ( $B'$ ), adapted to receive said at least one item of watermarking information ( $W'$ ); and
- means of sequencing, according to at least one predetermined  
15 criterion, at least one part of said set of acceptable regions ( $B'$ ), in an order which is invariant with respect to at least one of said geometric transformations.

24. Processing device according to Claim 23, characterised in that the determination and sequencing means are incorporated in:

- a microprocessor (1001);
- 20 - a read only memory (1008) containing at least one program (P1) for processing the coefficients ( $X_{ij}$ ); and
- a random access memory (1011) containing registers adapted to record variables modified during the execution of said at least one program.

25. Device for watermarking a set of coefficients ( $X_{ij}$ ) representing a  
25 digital image (300) which is liable to undergo a set of geometric transformations and said coefficients ( $X_{ij}$ ) being grouped together in regions ( $B'$ ), said device being characterised in that it has:

- means of determining, from amongst at least some of said regions, a set of so-called acceptable regions ( $B'$ ), adapted to receive said at least one  
30 item of watermarking information ( $W'$ );

- means of sequencing, according to at least one predetermined criterion, at least one part of said set of acceptable regions ( $B'$ ), in an order which is invariant with respect to at least one of said geometric transformations; and

- 5       - means of inserting at least one item of watermarking information ( $W'$ ), for at least certain regions ( $B'$ ) in said at least one part of said set of acceptable regions, said at least one item of watermarking information ( $W'$ ) being invariant with respect to at least one of said geometric transformations.

26. Watermarking device according to Claim 25, characterised in  
10   that the determination, sequencing and insertion means are incorporated in:

- a microprocessor (1001);
- a read only memory (1008) containing at least one program (P2) for watermarking the coefficients ( $X'_{ij}$ ); and
- a random access memory (1011) containing registers adapted

15   to record variables modified during the execution of said at least one program.

27. Device for decoding a watermarking code ( $C'$ ) consisting of at least one item of watermarking information ( $W''$ ) inserted in a set of coefficients ( $X'_{ij}$ ) representing a digital image (320), this image being liable to have undergone a set of geometric transformations and said coefficients ( $X'_{ij}$ ) being  
20   grouped together in regions ( $B''$ ), said device being characterised in that it has:

- means of determining, amongst at least some of said regions, a set of so-called acceptable regions ( $B''$ ), adapted to receive said at least one item of watermarking information ( $W''$ );

- means of determining a set of so-called watermarked regions ( $B''$ )  
25   amongst said set of acceptable regions, said watermarked regions having received said at least one item of watermarking information ( $W''$ );

- means of decoding said at least one item of watermarking information ( $W''$ ) for each of said watermarked regions;

- means of sequencing said watermarked regions ( $B''$ ) according to  
30   at least one predetermined criterion, in an order which is invariant with respect to at least one of said geometric transformations; and

- means of reconstituting said watermarking code (C') by sequencing the said watermarking information (W') as a function of said sequencing of said watermarked regions (B").

28. Device for decoding a watermarking code (C') according to Claim 27, characterised in that the means of determining a set of so-called acceptable regions (B"), of determining a set of so-called watermarked regions (B"), of decoding and of reconstituting said watermarking code are incorporated in:

- a microprocessor (1001);
- a read only memory (2008) containing at least one program (P3) for decoding the watermarking code (C'); and
- a random access memory (2011) containing registers adapted to record variables modified during the execution of said at least one program.

29. Programmable apparatus, characterised in that it has means adapted to implement the processing method according to any one of Claims 1 to 10.

30. Programmable apparatus, characterised in that it has means adapted to implement the watermarking method according to any one of Claims 11 to 15.

31. Programmable apparatus, characterised in that it has means adapted to implement the decoding method according to any one of Claims 16 to 22.

32. Information storage means, possibly totally or partially removable, which can be read by a computer or a processor containing instructions of a computer program, characterised in that it makes it possible to implement the processing method according to any one of Claims 1 to 10.

33. Information storage means, possibly totally or partially removable, which can be read by a computer or a processor containing instructions of a computer program, characterised in that it makes it possible to implement the watermarking method according to any one of Claims 11 to 15.

34. Information storage means, possibly totally or partially removable, which can be read by a computer or a processor containing instructions of a computer program, characterised in that it makes it possible to implement the decoding method according to any one of Claims 16 to 22.

5 35. Computer program product which can be loaded into a programmable apparatus, containing sequences of instructions or portions of software code for implementing the steps of the processing method according to any one of Claims 1 to 10, when said computer program is executed by a programmable apparatus.

10 36. Computer program product which can be loaded into a programmable apparatus, containing sequences of instructions or portions of software code for implementing the steps of the watermarking method according to any one of Claims 11 to 16, when said computer program is executed by a programmable apparatus.

15 37. Computer program product which can be loaded into a programmable apparatus, containing sequences of instructions or portions of software code for implementing the steps of the decoding method according to any one of Claims 16 to 22, when said computer program is executed by a programmable apparatus.